UserSimCRS

A User Simulator for Conversational Recommender Systems

System Evaluation using User Simulation

The following slides present the steps involved in evaluating an actual conversational recommender system, referred to as target CRS, using our user simulation toolkit.

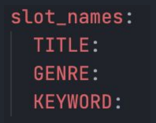
Prepare domain and item collection

A config file with domain-specific slot names must be prepared for the preference model. Additionally, a file containing the item collection is required; currently, this is expected in CSV format.

In our example:
The domain is `movies.yaml`. This document contains the slots necessary for the response generation and user modeling, when conversing with the target CRS.

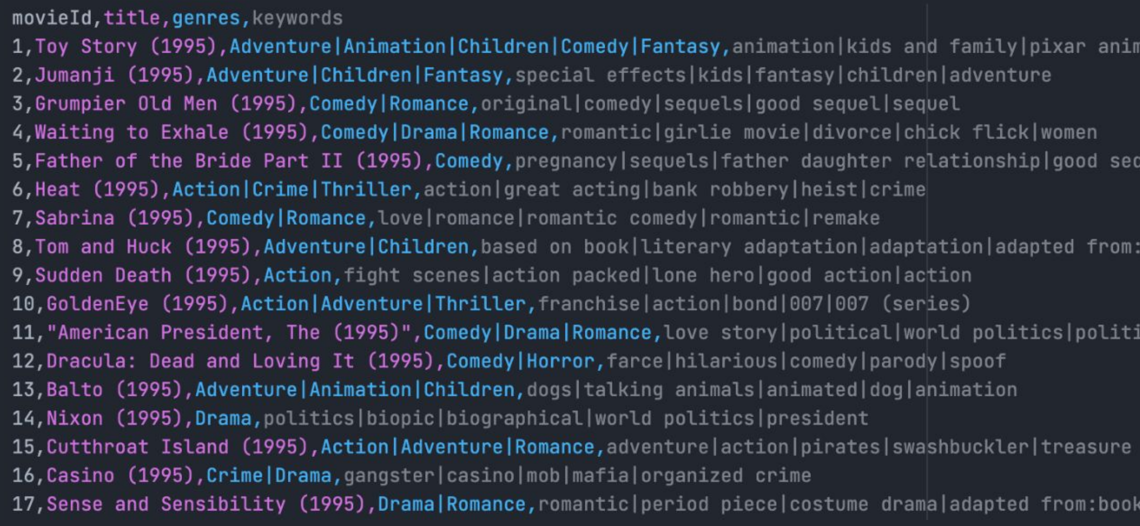
The item collection is the movielens 25M movies dataset. The movies.csv was expanded to contain the relevant domain slots for an item.

Domains/movies.yaml



```yaml
slot_names:
  TITLE:
  GENRE:
  KEYWORD:
```

Itemcollection/movies.csv



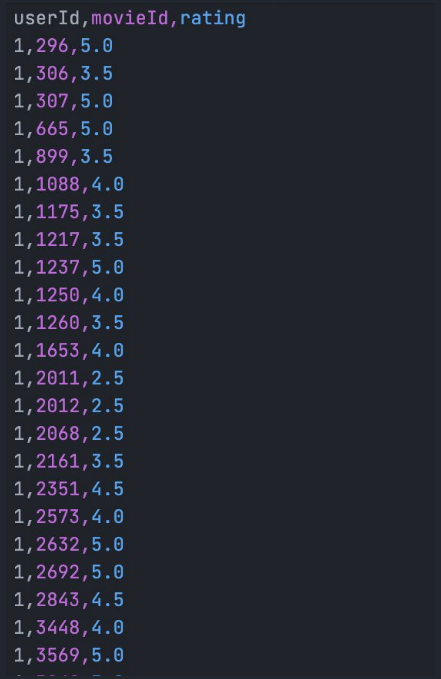
```
movieId,title,genres,keywords
1,Toy Story (1995),Adventure|Animation|Children|Comedy|Fantasy,animation|kids and family|pixar anim
2,Jumanji (1995),Adventure|Children|Fantasy,special effects|kids|fantasy|children|adventure
3,Grumpier Old Men (1995),Comedy|Romance,original|comedy|sequels|good sequel|sequel
4,Waiting to Exhale (1995),Comedy|Drama|Romance,romantic|girlie movie|divorce|chick flick|women
5,Father of the Bride Part II (1995),Comedy,pregnancy|sequels|father daughter relationship|good sec
6,Heat (1995),Action|Crime|Thriller,action|great acting|bank robbery|heist|crime
7,Sabrina (1995),Comedy|Romance,love|romance|romantic comedy|romantic|remake
8,Tom and Huck (1995),Adventure|Children,based on book|literary adaptation|adaptation|adapted from:
9,Sudden Death (1995),Action,fight scenes|action packed|lone hero|good action|action
10,GoldenEye (1995),Action|Adventure|Thriller,franchise|action|bond|007|007 (series)
11,"American President, The (1995)",Comedy|Drama|Romance,love story|political|world politics|politi
12,Dracula: Dead and Loving It (1995),Comedy|Horror,farce|hilarious|comedy|parody|spoof
13,Balto (1995),Adventure|Animation|Children,dogs|talking animals|animated|dog|animation
14,Nixon (1995),Drama,politics|biopic|biographical|world politics|president
15,Cutthroat Island (1995),Action|Adventure|Romance,adventure|action|pirates|swashbuckler|treasure
16,Casino (1995),Crime|Drama,gangster|casino|mob|mafia|organized crime
17,Sense and Sensibility (1995),Drama|Romance,romantic|period piece|costume drama|adapted from:book
```

Provide preference data

Preference data is consumed in the form of item ratings and needs to be provided in a CSV file in the shape of user ID, item ID, and rating triples.

In our example:
The preference data is the movielens 25M ratings.

```
Itemcollection/ratings.csv
```



```
userId,movieId,rating
1,296,5.0
1,306,3.5
1,307,5.0
1,665,5.0
1,899,3.5
1,1088,4.0
1,1175,3.5
1,1217,3.5
1,1237,5.0
1,1250,4.0
1,1260,3.5
1,1653,4.0
1,2011,2.5
1,2012,2.5
1,2068,2.5
1,2161,3.5
1,2351,4.5
1,2573,4.0
1,2632,5.0
1,2692,5.0
1,2843,4.5
1,3448,4.0
1,3569,5.0
```

Dialogue sample

A small sample of dialogues with the target CRS needs to be collected. The sample size depends on the complexity of the system, in terms of action space and language variety, but is generally in the order of 5-50 dialogues.

```
DialogueSamples/target_crs_sample.json
```

```json
[
 {
   "conversation ID": "\"39GHHAVOMGCMCWD43ZNZ2ARD9RF4JH\"",
   "conversation": [
     {
       "participant": "AGENT",
       "utterance": "Hi there. I am IAI MovieBot, your movie recommending buddy. I can re…"
     },
     {
       "participant": "USER",
       "utterance": "hello\n"
     },
     {
       "participant": "AGENT",
       "utterance": "Which genres do you prefer?\n"
     },
     {
       "participant": "USER",
       "utterance": "action, fantasy\n"
     },
     {
       "participant": "AGENT",
       "utterance": "I have found almost 500 fantasy and action films. Can you guide me more…"
     },
     {
       "participant": "USER",
       "utterance": "something like the lord of the rings\n"
     },
     {
       "participant": "AGENT",
       "utterance": "There is a fantasy and action, lord film named Kung Fu Hustle. Have you …"
     },
     {
       "participant": "USER",
       "utterance": "anything else?\n"
     },
     {
       "participant": "AGENT",
       "utterance": "There is a fantasy and action, lord film named Conan the Barbarian. Have …
     },
     …
…
```

Define interaction model

A config file containing the users' and agent's intent space, as well as the set of expected agents for each user intent, is required for the interaction model. The CRSv1 interaction model shipped with library offers a baseline starting point, which may be further tailored according to the behavior and capabilities of the target CRS.

interaction_models/CRSv1.yaml

```yaml
# Possible user intents with optional description.
user_intents:
 COMPLETE:
   expected_agent_intents:
     - END
 DISCLOSE.NON-DISCLOSE:
   expected_agent_intents:
     - INQUIRE
     - INQUIRE.ELICIT
     - DISCLOSE.NON-DISCLOSE
 DISCLOSE:
   expected_agent_intents:
     - INQUIRE.ELICIT
     - REVEAL
     - REVEAL.NONE
 REVEAL:
   expected_agent_intents:
 REVEAL.EXPAND:
   expected_agent_intents:
     - INQUIRE.ELICIT
     - REVEAL
     - REVEAL.NONE
 REVEAL.REFINE:
   expected_agent_intents:
     - INQUIRE.ELICIT
     - REVEAL
     - REVEAL.NONE
         .
         .
         .

# List of agent intents (including sub-intents) that elicit preferences.
agent_elicit_intents:
 - INQUIRE
 - INQUIRE.ELICIT

# List of agent intents (including sub-intents) that are for set retrieval.
agent_set_retrieval:
 - REVEAL
 - REVEAL.SIMILAR
 - REVEAL.NONE
```

Annotate sample

The sample of dialogues must contain utterance-level annotations in terms of intents and entities, as this is required to train the NLU and NLG components. Note that the slots used for annotation should be the same as the ones defined in the domain file (cf. Step 1) and intents should follow the ones defined in the interaction model (cf. Step 4.).

DialogueSamples/target_crs_sample_annotated.json

```
[
 {
   "conversation ID": "\"39GHHAVOMGCMCWD43ZNZ2ARD9RF4JH\"",
   "conversation": [
     {
       "participant": "AGENT",
       "utterance": "Hi there. I am IAI MovieBot, your movie recommending buddy. I can recom…,
       "intent": "DISCLOSE.NON-DISCLOSE"
     },
     {
       "participant": "USER",
       "utterance": "hello\n",
       "intent": "DISCLOSE.NON-DISCLOSE"
     },
     {
       "participant": "AGENT",
       "utterance": "Which genres do you prefer?\n",
       "intent": "INQUIRE.ELICIT",
       "slot_values": [
         [
           "GENRE",
           "genres"
         ]
       ]
     },
     {
       "participant": "USER",
       "utterance": "action, fantasy\n",
       "intent": "DISCLOSE",
       "slot_values": [
         [
           "GENRE",
           "action"
         ],
         [
           "GENRE",
           "fantasy"
         ]
       ]
     },
     …
 …
```

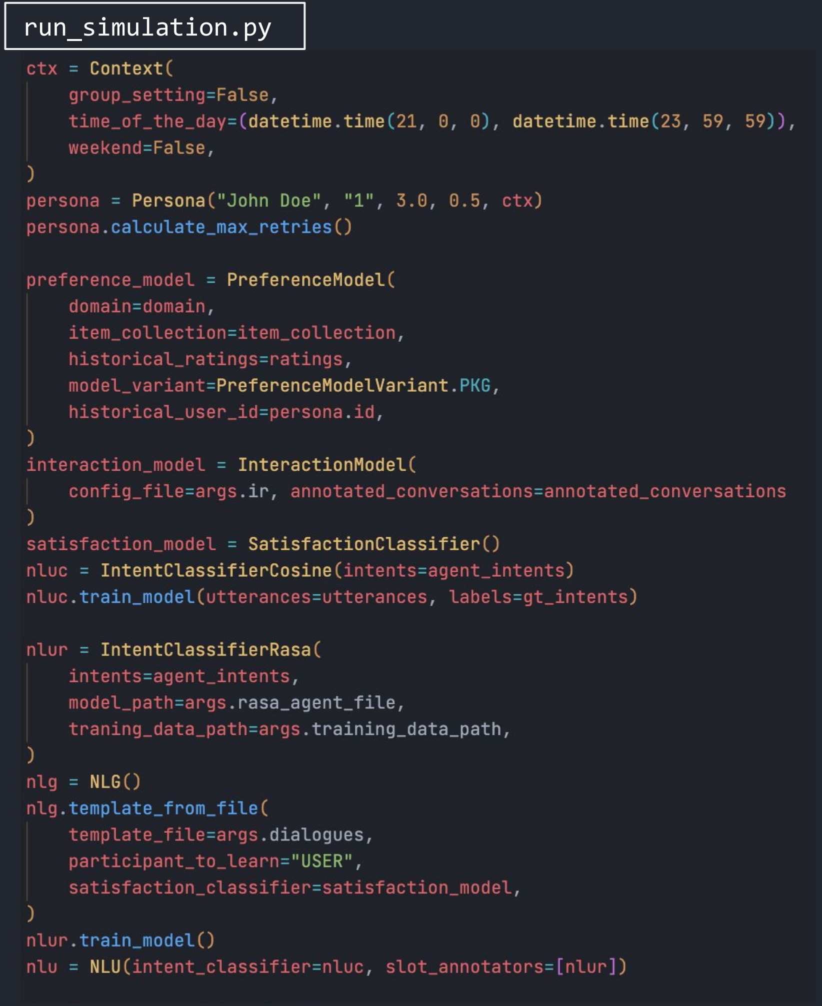
Define user model/population

Simulation is seeded with a user population that needs to be characterized, in terms of the different contexts (e.g., weekday vs. weekend, alone vs. group setting) and personas (e.g., patient and impatient users) and the number of users to be generated for each combination of context and persona. Each user has their own preference model, which may be instantiated by grounding it to actual preferences (i.e., the ratings dataset given in Step 2).

```
pg = PersonaGenerator()
pg.satisfaction_function(loc=3.0, scale=1.0)
pg.sample_context(group_probability=3/4, weekend_probability=3/7)
personas = pg.generate_personas(amount=1000)
```

Train simulator

The NLU and NLG components of the simulator are trained using the annotated dialogue sample.



run_simulation.py

```python
ctx = Context(
    group_setting=False,
    time_of_the_day=(datetime.time(21, 0, 0), datetime.time(23, 59, 59)),
    weekend=False,
)
persona = Persona("John Doe", "1", 3.0, 0.5, ctx)
persona.calculate_max_retries()

preference_model = PreferenceModel(
    domain=domain,
    item_collection=item_collection,
    historical_ratings=ratings,
    model_variant=PreferenceModelVariant.PKG,
    historical_user_id=persona.id,
)
interaction_model = InteractionModel(
    config_file=args.ir, annotated_conversations=annotated_conversations
)
satisfaction_model = SatisfactionClassifier()
nluc = IntentClassifierCosine(intents=agent_intents)
nluc.train_model(utterances=utterances, labels=gt_intents)

nlur = IntentClassifierRasa(
    intents=agent_intents,
    model_path=args.rasa_agent_file,
    traning_data_path=args.training_data_path,
)
nlg = NLG()
nlg.template_from_file(
    template_file=args.dialogues,
    participant_to_learn="USER",
    satisfaction_classifier=satisfaction_model,
)
nlur.train_model()
nlu = NLU(intent_classifier=nluc, slot_annotators=[nlur])
```

Run simulation

Running the simulator will generate a set of simulated conversations for each user with the target CRS and save those to files.

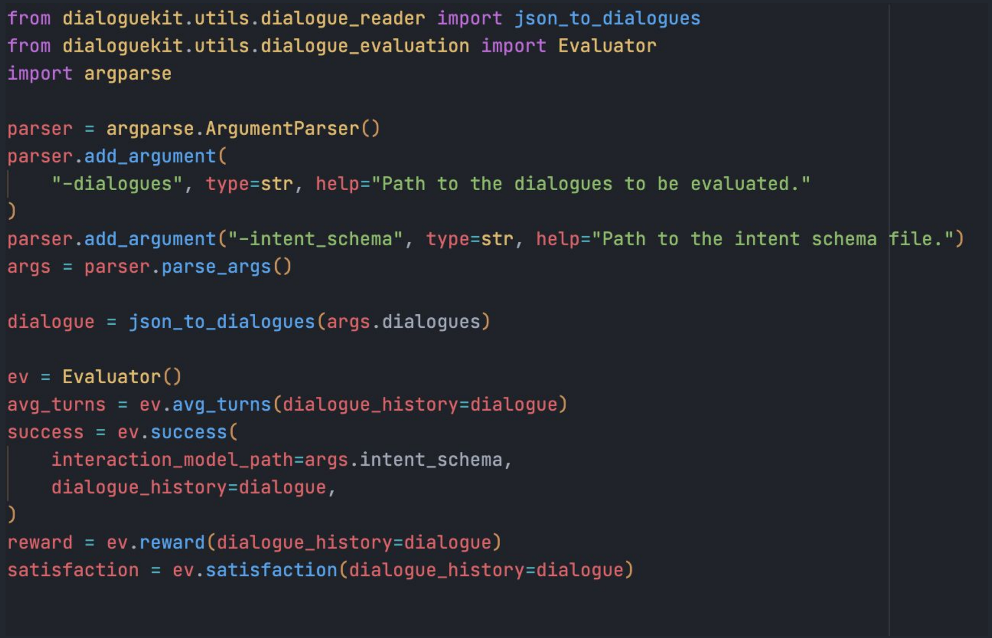
run_simulation.py

```python
simulator = AgendaBasedSimulator(
    id="simulator",
    preference_model=preference_model,
    interaction_model=interaction_model,
    nlu=nlu,
    nlg=nlg,
    domain=domain,
    item_collection=item_collection,
    ratings=ratings,
    persona=persona,
    satisfaction_model=satisfaction_model,
)
agent = MovieBotAgent(agent_id="14", uri="http://152.94.232.28:5001")
simulate_conversation(agent, simulator)
```

Perform evaluation

Evaluation takes the set of simulated dialogues generated in the previous step as input, and measures the performance of the target CRS in terms of the metrics implemented in DialogueKit (cf. Section 3.1).

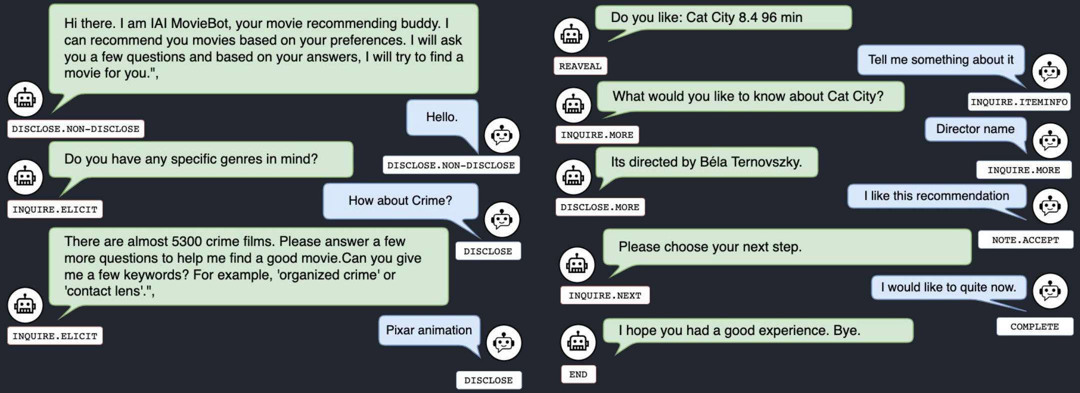
evaluate_simulation.py



```python
from dialoguekit.utils.dialogue_reader import json_to_dialogues
from dialoguekit.utils.dialogue_evaluation import Evaluator
import argparse

parser = argparse.ArgumentParser()
parser.add_argument(
    "-dialogues", type=str, help="Path to the dialogues to be evaluated."
)
parser.add_argument("-intent_schema", type=str, help="Path to the intent schema file.")
args = parser.parse_args()

dialogue = json_to_dialogues(args.dialogues)

ev = Evaluator()
avg_turns = ev.avg_turns(dialogue_history=dialogue)
success = ev.success(
    interaction_model_path=args.intent_schema,
    dialogue_history=dialogue,
)
reward = ev.reward(dialogue_history=dialogue)
satisfaction = ev.satisfaction(dialogue_history=dialogue)
```

Example simulated dialogue

In this example, the target CRS is IAI MovieBot.



Hi there. I am IAI MovieBot, your movie recommending buddy. I can recommend you movies based on your preferences. I will ask you a few questions and based on your answers, I will try to find a movie for you.",

DISCLOSE.NON-DISCLOSE

Hello.

DISCLOSE.NON-DISCLOSE

Do you have any specific genres in mind?

INQUIRE.ELICIT

How about Crime?

DISCLOSE

There are almost 5300 crime films. Please answer a few more questions to help me find a good movie.Can you give me a few keywords? For example, 'organized crime' or 'contact lens'.",

INQUIRE.ELICIT

Pixar animation

DISCLOSE

Do you like: Cat City 8.4 96 min

REAVEAL

Tell me something about it

INQUIRE.ITEMINFO

What would you like to know about Cat City?

INQUIRE.MORE

Director name

INQUIRE.MORE

Its directed by Béla Ternovszky.

DISCLOSE.MORE

I like this recommendation

NOTE.ACCEPT

Please choose your next step.

INQUIRE.NEXT

I would like to quite now.

COMPLETE

I hope you had a good experience. Bye.

END